# Effects of Mount Pleasant Tungsten Mine Effluent on Biota of Hatch Brook

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# EFFECTS OF MOUNT PLEASANT TUNGSTEN MINE EFFLUENT ON BIOTA OF HATCH BROOK

by

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## ABSTRACT

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Fish populations and benthic invertebrates were assessed in a stream receiving effluent from a tungsten mine in southwestern New Brunswick. Major fish species were brook trout (Salvelinus fontinalis), blacknose dace (Rhinichthys atratulus), pearl dace (Semotilus margarita) and white sucker (Catostomus commersoni). Brook trout were absent from the electrofishing sites immediately downstream of the confluence of the effluent with the stream but were present a few hundred meters downstream. Among the major groups of benthic invertebrates sampled, Diptera larvae were most abundant near the confluence of the effluent inlet stream and numbers generally decreased with distance downstream from the input. Ephemeroptera and Plecoptera nymphs showed the reverse trend and generally increased in number with increasing distance downstream.



## RÉSUMÉ

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Les populations de poissons et les invertébrés benthiques d'un cours d'eau recevant l'effluent d'une mine de tungstène du sud-ouest du Nouveau-Brunswick ont été évalués. Les principales espèces de poissons sont l'omble de fontaine (Salvelinus fontinalis), le naseux noir (Rhinichthys atratulus), le mulet perlé (Semotilus margarita) et le meunier noir (Catostomus commersoni). L'omble de fontaine est absent des sites d'électropêche immédiatement en aval de l'arrivée de l'effluent dans le cours d'eau, mais présent à quelques centaines de mètres plus bas. Parmi les principaux groupes d'invertébrés échantillonnés, les larves de Diptera sont les plus abondantes près de l'entrée de l'effluent dans le cours d'eau et, en général, leur nombre diminue en fonction de la distance en aval. On observe une tendance inverse chez les nymphes d'Ephemeroptera et de Placoptera, leur nombre augmentant généralement en fonction de la distance en aval.

## INTRODUCTION

Renewal of mining activity at Mount Pleasant 40 km north of St. George, New Brunswick, by Brunswick Tin Mines Ltd. in the spring of 1980 included pumping out of the flooded mine shaft on the south side of Mount Pleasant (Fig. 1). Sump water was treated with lime, passed into a settling pond and the overflow seeped downhill through a forested area a distance of 100-200 m to Hatch Brook, a tributary of the Piskahegan River which in turn is a tributary of the Magaguadavic River. The upper Piskahegan River and Hatch Brook are popular for brook trout fishing.

Sprague et al. (1965), Saunders and Sprague (1967), Elson et al. (1973) and Elson (1974) have shown that effluents from mining on the headwaters of the Tomogonops River, tributary to the northwest Miramichi River, New Brunswick, resulted in decreases in bottom fauna and resident fish as well as fallback of migrating adult Atlantic salmon.

At Mount Pleasant, construction of an ore milling facility and mining shafts continued until 1983 (Fig. 2). On March 17, 1983 heavy silt loads observed in Hatch Brook were investigated by the New Brunswick Department of Natural Resources and traced to unauthorized discharge of 3000 t of inorganic silt from the Mount Pleasant Tungsten Mine related to "initial phase-in" trials. Assessment of the situation by New Brunswick Department of Natural Resources' staff stated "silt loads to Hatch Brook were potentially great enough to obliterate all brook trout fall spawning activities in Hatch Brook and place excessive physiological stress on juvenile and adult salmonids in Hatch Brook and the Piskahegan River downstream of the confluence. Brook trout and Atlantic salmon forage (aquatic insects and minnow species) would have certainly been adversely influenced" (P. Cronin, pers. comm.).

Field investigations were undertaken to determine effects on fish populations attributable to sump-water discharge in 1980 and effluent discharge from phase-in trials in 1983. The information collected and presented here may serve as a baseline for Hatch Brook and the Piskahegan and Magaguadavic rivers.

## STUDY SITES

In 1980 a representative site, consisting of pool, riffle and run type of stream habitat, was selected on Hatch Brook approximately 1.5 km downstream of its confluence with the mine sump discharge. A similar site with respect to habitat type was selected on Lower Miles Brook located approximately 5 km north of Hatch Brook to serve for comparison purposes.

Sampling sites in 1983 included the 1980 Hatch Brook site and two other locations upstream of the 1980 site but downstream of the confluence of discharge from the Mount Pleasant Tungsten Mine. A sampling site near the mouth of the Piskahegan River 200 m upstream from its confluence with the Magaguadavic River was also selected. Additionally, a site on Hatch Brook at the point of entry of discharge from the settling pond and another site on the Piskahegan River were chosen for "spot checks" of fish numbers and species present. An attempt to select a control study site on Hatch Brook upstream of mine activity was unsuccessful due to lack of comparable habitat to the downstream sites. Locations of study sites are shown in Fig. 3.

## MATERIALS AND METHODS

To obtain data on numbers and species of fish, a section of stream at each sampling site was electrofished progressively upstream using barrier nets at top and bottom of the section to prevent fish from moving into or out of the area during the operation. Electrofishing was performed at 400-500 V with Smith-Root back-pack electrofishers (Mark IV and Mark VII) using uninterrupted direct current. Three sweeps of each section were performed.

Captured fish were anaesthetized with tertiary amyl alcohol and measured to the nearest millimeter and weighed to the nearest gram. Fish from each sweep were retained in a screened holding box outside the fishing section until all sweeps were completed. Fish were allowed to recover from the anaesthetic and then returned to the section from which they had been captured. Estimates of fish population densities were made by the DeLury method (Zippin 1956).

Spot checks, conducted at two sites, consisted of a single sweep with the electrofisher, counting the number of each species caught within a 20-min period.

Standing crop of aquatic invertebrates was sampled in riffle areas within or near electrofishing sections by 0.09 $m^2$ Surber samplers with a net of 0.5-mm square mesh. Organisms were dislodged from within the 0.09 $m^2$ area of stream bottom delineated by the frame to a depth of approximately 5 cm. Invertebrates collected were preserved in 70% ETOH to be subsequently identified, counted, and tabulated as means with ranges of the replicate samples taken at each site.

Drift nets, which sampled a 2.5-cm wide column of water from surface to bottom, were employed over a 24-h period in Hatch Brook June 14, 15 and 16, 1983, at sites B, C and D. Measurements of stream velocity and depth of water column sampled were recorded. The taxa comprising drift were expressed as number of organisms per cubic meter of water filtered by the drift nets.

In 1980, samples of water, sediment, aquatic vegetation, fish and aquatic insects were collected from Hatch Brook and stored frozen at Dr. Ray's laboratory at the St. Andrews Biological Station until future scientific investigations warrant analysis for pollutants. Information on pH, conductivity and temperature was recorded at the time of sampling.

## RESULTS

Physical characteristics of the electrofishing sections are presented in Table 1.

Population estimates and the actual catches of fish from each electro-fishing section are given in Table 2. Brook trout densities in Hatch Brook Site #3 on June 12, 1980 were 8.7 trout/100 $m^2$, similar to trout densities on June 13, 1983, (9.0 trout/100 $m^2$). Site #2 on Hatch Brook was located 300 m

Fig. 1. Mount Pleasant mine site May 1980.

Fig. 2. Mount Pleasant mine site October 1982.

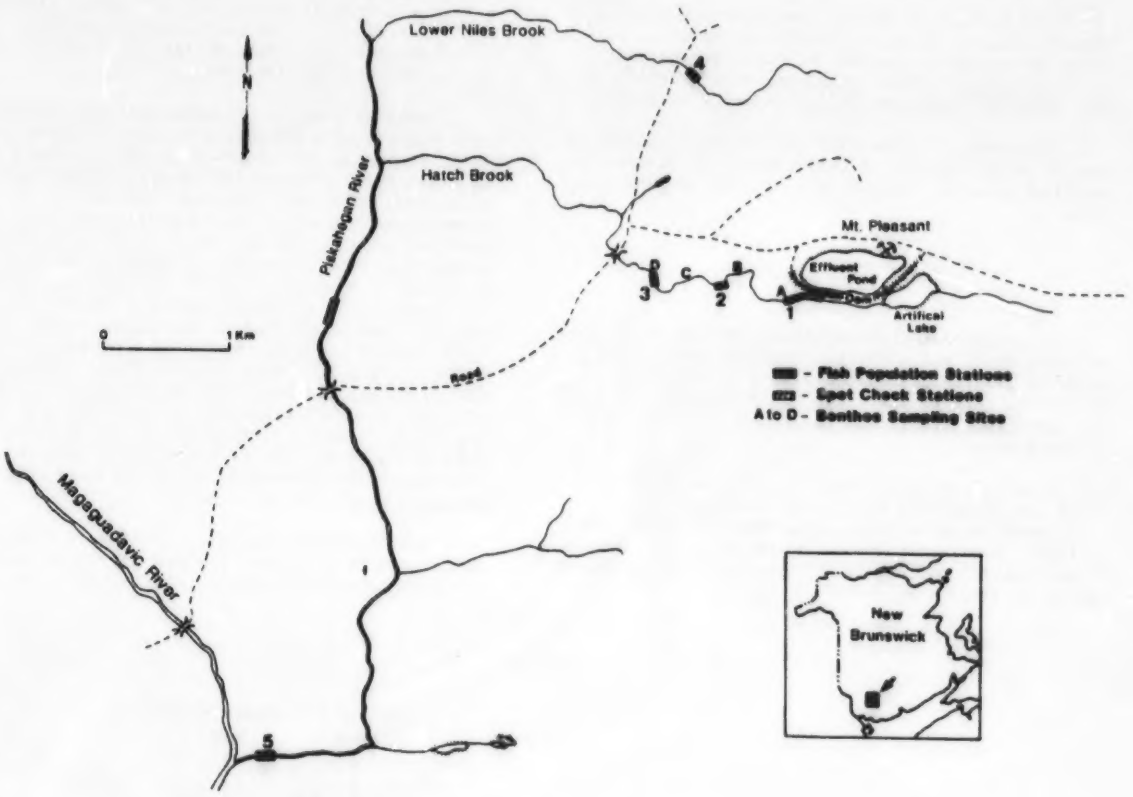


Fig. 3. Study sites.

upstream of Site #3 and had 9.9 trout/100 $m^2$. Site #1 on Hatch Brook was approximately 500 m upstream of Site #2 and approximately 100 m below the confluence of the Mount Pleasant Mine tailings pond. No trout were found in this section although the habitat appeared to be suitable for trout. Other species present in Hatch Brook included blacknose dace, pearl dace, suckers, threespine sticklebacks and common shiners.

The electrofishing site on Lower Niles Brook, fished on June 13, 1980 contained 19.5 trout/100 $m^2$. Blacknose dace, pearl dace and suckers were also caught (Table 2).

An electrofishing site near the mouth of the Piskahegan River yielded 10.9 Atlantic salmon fry/100 $m^2$ and 1 Atlantic salmon parr/100 $m^2$. Also present in this section were dace and slimy sculpins.

A spot check of the Piskahegan River downstream of the confluence of Hatch Brook yielded no salmonids but fair numbers of cyprinids (Table 3). The habitat appeared suitable for juvenile Atlantic salmon with lots of riffle areas and a suitable bottom type; however a natural falls 6 km downstream prevents Atlantic salmon access. Water temperature at the time of sampling in mid-August was 21.5°C and trout would most likely have been found in areas receiving cooler spring water.

A spot check of Hatch Brook for 100 m immediately downstream of the confluence of the tailings pond revealed only one small trout and fair numbers of cyprinids (Table 3). Much of the stream bottom in this area was overlain with sand and sediment which appeared to have been washed downstream from construction activities related to the formation of the tailings pond and the diversion channel of Hatch Brook.

Assessment of the electrofishing areas in terms of fish biomass is expressed in grams per 100 $m^2$ of wetted streambed and separated for salmonids and other species (Table 4). Hatch Brook Site #3 fish biomass in June 1980 was 75.0 g/100 $m^2$ while in June 1983 it was 76.7 g/100 $m^2$. The brook trout composition in 1980 was 9% while in 1983 it was 53%. The 19 brook trout caught in 1980 were all young-of-the-year fish (age 0+); in 1983, the 16 brook trout caught at this site were comprised of 13 age 0+ fish and three older and much larger trout, accounting for the larger percentage of trout biomass.

Mean lengths of young-of-the-year brook trout caught at Site #3 on Hatch Brook on June 12, 1980, were 45 $\pm$ 4 mm (n=17) and on June 13, 1983, were

46 ± 8 mm (n=13). Not enough older trout were caught for accurate size comparisons between years.

Mean numbers of benthic invertebrates collected from a total of 19 Surber samples at sites A, B, C and D are presented in Fig. 4. Chironomids and other Dipterans, mainly Simulium, were generally the most numerous organisms in the majority of samples.

Mean numbers of benthic invertebrates collected from 10 drift samples in the vicinity of benthos sampling sites B, C and D (Fig. 3) are presented in Table 5.

## SUMMARY AND CONCLUSIONS

Comparison of electrofishing results at Site #3 on Hatch Brook and a control site on Lower Niles Brook in 1980 indicated the same fish species present in both brooks. The Lower Niles Brook site had more brook trout than the Hatch Brook site which had more dace.

Electrofishing of Site #3 on Hatch Brook 3 mo after the March 1983 mine spill indicated brook trout numbers to be similar to those obtained there in 1980. Young-of-the-year brook trout were present in both years, indicating successful hatching in the spring of 1983 in spite of the spill. It is doubtful that young-of-the-year brook trout were displaced downstream from above the confluence of Mount Pleasant Mine effluent with Hatch Brook due to a barren 0.5-km diversion channel and an artificial lake created above the confluence which would likely have hindered downstream passage of trout fry in such a short period of time.

Sampling results of stream benthos indicate fair numbers of macroinvertebrates available both as a standing crop and actively drifting. There was an apparent general reduction in chironomids and other dipterans and a corresponding increase in Ephemeroptera and Plecoptera downstream from the effluent source. Winner et al. (1980) showed a graded response of macroinvertebrates to heavy-metal pollution. Heavily polluted habitats were dominated by midges while minimally polluted or unpolluted habitats were dominated by mayflies. Welch et al. (1977) found a similar response with respect to sedimentation from road construction. Sedimentation due to forest clearing and construction of the effluent pond and diversion channel appeared to be the major cause of degradation of brook trout habitat (as indicated by brook trout absence) immediately downstream of the confluence of the effluent pond with Hatch Brook.

Monthly monitoring since 1982 by New Brunswick Department of Environment indicates water quality to be within acceptable limits (G. Choate, pers.

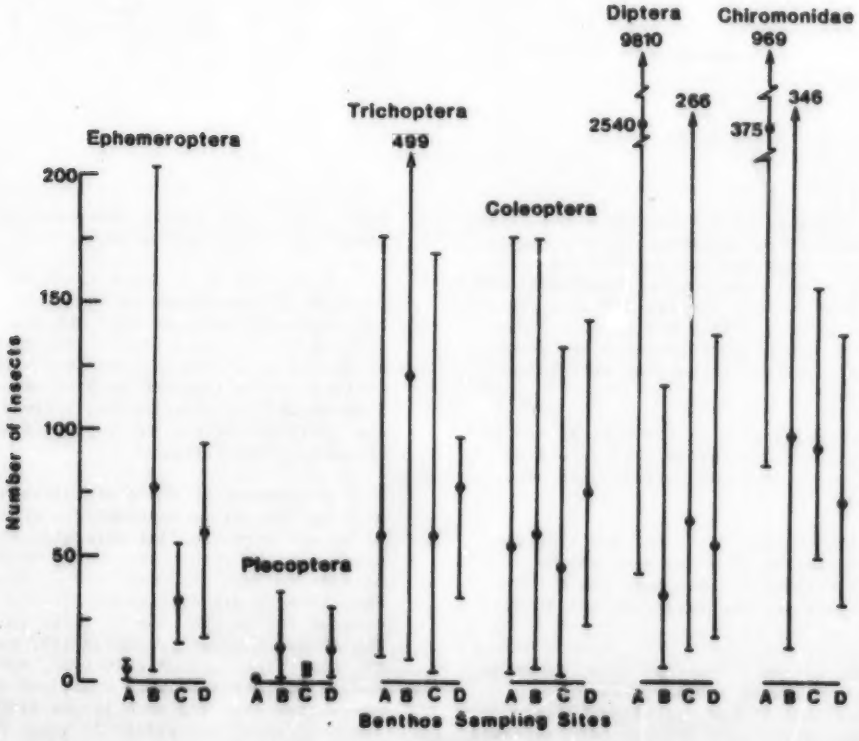


Fig. 4. Mean numbers and ranges of benthic invertebrates collected in Surber samples at four stations on Hatch Brook June 12-August 11, 1983. Number of replicate samples: A = 4, B = 5, C = 6, D = 4.

comm.). Water samples collected during the 1983 spill by New Brunswick Department of Natural Resources' personnel (P. Cronin, pers. comm.) indicated high levels of total solids downstream of the mine, with particularly high concentrations of zinc and aluminum compared with chemical data collected by Carson (1966) for the same area.

The results of this survey indicate that 3 mo after the spill incident fish populations in Hatch Brook were comparable to those present 3 yr earlier. There was successful hatching of the 1983 year-class brook trout, and fish forage in the form of benthic invertebrates and cyprinids was present in reasonable abundance and diversity. There was, however, a noticeable difference in stream bottom substrate for several hundred meters downstream of the effluent pond, which was also reflected in stream biota. The source of sedimentation in the form of sand and silt was probably related to both the spill and construction activities from the effluent pond area. Although sampling in this study was rather limited, the information collected should help form a data base should future environmental incidents occur at the Mount Pleasant Tungsten Mine.

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Table 1. Physical characteristics of electrofishing sections.

| Site | Date | Water temp. (°C) | $\bar{x}$ Depth (cm) | Length (m) | $\bar{x}$ Width (m) | Area ($m^2$) | Bottom characteristics[a] |
|---|---|---|---|---|---|---|---|
| Hatch Brook #3 | 12/06/80 | 12.5 | 20 | 60 | 3.55 | 213 | 40% sand, 20% gravel, 30% cobble, 10% boulder |
| Hatch Brook #3 | 13/06/83 | 16.0 | 43 | 45.7 | 3.70 | 240 | - - - - |
| Hatch Brook #2 | 28/06/83 | 22.0 | 30 | 35 | 3.67 | 146 | 10% silt, 10% sand, 60% gravel, 10% cobble, 10% boulder |
| Hatch Brook #1 | 05/07/83 | 20.5 | 25 | 25 | 4.38 | 109.5 | 10% silt, 40% sand, 20% gravel, 25% cobble, 5% boulder |
| Lower Niles Brook | 13/06/83 | 14.0 | 15 | 50 | 3.29 | 164.5 | 40% gravel, 50% cobble, 10% boulder |
| Piskahegan River | 16/08/83 | 21.5 | 21 | 25 | 12.5 | 312.5 | 85% gravel, 10% cobble, 5% boulder |

[a]Buchanan 1984.

Table 2. Zippin population estimates (actual catches) of fish species per 100 $m^2$ from electrofishing sites. Hyphen indicates population estimate could not be calculated from available data.

| Site | Date | Brook trout | Blacknose dace | Pearl dace | White sucker | Threespine stickleback | Common shiner | Atlantic salmon |
|---|---|---|---|---|---|---|---|---|
| Hatch Brook #3 | 12/06/80 | 9.0(8.9) | 32.5(27.2) | 14.8(11.5) | - (0.8) | 0 | 0 | |
| Hatch Brook #3 | 13/06/83 | 8.7(6.7) | 16.7(16.7) | - (1.7) | 6.1 (2.9) | 0 | 0 | |
| Hatch Brook #2 | 28/06/83 | 9.9(9.6) | 156.7(52.7) | 10.5(10.3) | 4.8 (4.8) | 0 | 0 | |
| Hatch Brook #1 | 05/07/83 | 0 | -(26.5) | -(11.9) | 116.0(88.6) | -(4.6) | -(0.6) | |
| Lower Niles Brook | 13/06/83 | 19.5(19.5) | 11.7(11.6) | - (0.6) | - (0.6) | 0 | 0 | |
| Piskahegan River | 16/08/83 | 0 | - (6.1) | 2.6 (0.6) | 0 | 0 | 0 | -(11.9) |

Table 3. Fish species and numbers caught in 20 min electrofishing spot checks.

| Site | Date | Brook trout | Blacknose dace | Pearl dace | White sucker | Threespine stickleback |
|---|---|---|---|---|---|---|
| Hatch Brook (immediately downstream of confluence of mine effluent) | 08/07/84 | 1 | 63 | 19 | 26 | 2 |
| Piskahegan River (3 km downstream of confluence of Hatch Brook) | 16/08/84 | 0 | 49 | 1 | 12 | 0 |

Table 4. Fish biomass (g/100 $m^2$) in population study sites.

| Site | Year | Salmonids wt (g) | Salmonids % | Other species wt (g) | Other species % | Total biomass (g/100 $m^2$) |
|---|---|---|---|---|---|---|
| Hatch Brook #3 | 1980 | 7.0 | 9 | 68.0 | 81 | 75.0 |
| Hatch Brook #3 | 1983 | 40.4 | 53 | 36.3 | 47 | 76.7 |
| Hatch Brook #2 | 1983 | 340.4 | 54 | 286.3 | 46 | 626.7 |
| Hatch Brook #1 | 1983 | 0 | 0 | 146.1 | 100 | 146.1 |
| Lower Niles Brook | 1980 | 23.1 | 30 | 53.5 | 70 | 76.6 |
| Piskahegan River | 1983 | 21.1 | 57 | 16.0 | 43 | 37.1 |

Table 5. Mean numbers of aquatic invertebrates from 10 drift samples on Hatch Brook collected June 14-16, 1983.

| | $\bar{x}$ | s.d. | no./$m^3$ water sampled |
|---|---|---|---|
| Ephemeroptera | 30.9 | 22.3 | 2.6 |
| Plecoptera | 2.7 | 2.3 | 0.2 |
| Trichoptera | 8.0 | 9.7 | 0.7 |
| Diptera[a] | 68.1 | 80.1 | 5.7 |
| Coleoptera | 6.5 | 6.8 | 0.5 |
| Oligochaeta | 14.2 | 15.7 | 1.2 |
| Amphipoda | 64.8 | 118.4 | 5.4 |
| Miscellaneous[b] | 3.4 | 4.8 | 0.3 |

[a]Chiefly Chironomidae and Simuliidae larvae.
[b]Includes Odonata, Hydracarina, terrestial Arthropods, Amphipoda, Collembola.